



## MARKED-UP COPY OF SPECIFICATION

### METHOD OF INFRARED STEERING AND SYSTEM THEREOF FOR CONTROLLING STEERING DEVICES USING INFRARED SIGNALS

#### Field of Invention

The present invention relates to ~~an infrared~~ a steering system ~~for steering with use of an infrared ray a device which receives a radio signal through a means for transmitting a radio signal~~ that uses infrared signals to convey steering information.

#### Background Art

The conventional infrared steering system for steering a plurality of conventional steered cars controls each steered object by transmitting, with time-sharing, ~~[[a]]~~ steering information and an object identification signal for specifying the steered object from each transmitting means. Furthermore, this transmitting means may identify the other transmitting means used in the vicinity simultaneously and is synchronized with signal transmission timing ~~between~~ among reciprocal transmitting means to ~~[[and]]~~ control separately about four steered cars.

The above-mentioned conventional infrared steering system, however, entails a problem ~~[[of]]~~ in the limited number of the steered cars capable of travelling simultaneously on account of ~~use of~~ the prolonged time for

transmission of each object identification information and digital steering ~~informations.~~ information.

Thus, an object of the present invention is to provide an infrared steering system and a method thereof for ~~enabling to increase~~ increasing the number of the ~~objective~~ steered cars capable of travelling simultaneously by reducing a transmission time occupied by each transmission device in transmitting and receiving the steering information as an analog signal free of the object identification signal.

### **Disclosure Summary of the Invention**

A steering method and system controls a plurality of infrared units with a plurality of infrared controllers. The infrared controller sets the time interval between the end of a start signal and the start of a steering signal to match a predetermined time interval specific to each infrared unit being controlled.

~~An infrared steering system according to the invention comprises a carrier wave generating means for producing an infrared carrier wave signal, an inputting means for receiving a steering information according to an operation, an object setting means for providing an object identification information for specifying a steered object, a means for discovering a transmission information from another transmitting means and then transmitting when a synchronization signal is received the steering information by the identification information after a specific waiting time, a means for transmitting a synchronization signal when free and then~~

~~transmitting the steering information from the identification information after the specific waiting time, a means for receiving the infrared carrier wave signal, a self-setting means for providing a self identification information, a means for extracting the self steering information from the reception signal by means of the self identification information, a signal conversion means for converting the extracted steering information into a driving signal, and a drive controlling means for operating a driving means in response to the driving signal. According to the present invention, only the common synchronization signal and a plurality of steering informations are used without outputting individual identification signal to minimize the transmission time occupied by each transmitting means.~~

~~Furthermore, the infrared steering method according to the present invention for controlling a plurality of infrared controlled devices with a plurality of infrared controlling devices is characterized in that a matching signal is identified as a signal for the infrared controlled device in comparison with a time interval between the termination time of a start signal and the initiation time of a steering signal transmitted by the infrared controlling device with a specific time interval previously fixed in every infrared controlled device.~~

~~The infrared controlling device may transmit the synchronization signal and the start signal and may output the steering signal after the waiting time previously determined.~~

~~The infrared controlling device may output the start signal when the infrared signal transmitted by the other infrared controlling device with the~~

~~synchronization signal is received and may output the start signal after outputting the synchronization signal when free.~~

~~—— A specific time length previously fixed in every infrared controlled device or the time interval between the termination time of the start signal and the initiation time of the steering signal may be determined in accordance with a layout of switch provided in an ID setting section of the infrared controlling device.~~

~~—— The infrared controlled device receives the synchronization signal and the start signal, further receives the steering signal to measure the time interval between the termination time of the start signal and the initiation time of the steering signal and compares with the waiting time fixed previously for self identification.~~

~~—— Also, the infrared steering system according to the present invention for controlling a plurality of infrared controlled devices with a plurality of infrared controlling devices is characterized in that the matching signal is identified as a signal for the infrared controlled device in comparing the time interval between the termination time of the start signal and the initiation time of the steering signal with the specific time interval previously fixed in every infrared controlled device.~~

~~—— The infrared controlling device according to the invention may provide an inputting means for receiving the steering information, an object setting means for providing an object identification information for specifying a steered object, a means for transmitting the steering information, and a means for receiving a transmission signal of the other infrared controlling~~

device.

~~———— The infrared controlled device according to the invention may provide a self setting means for providing self identification information, a means for extracting self steering information from the reception signal by means of the self identification information, a signal converting means for converting the extracted steering information into a driving signal, and a drive controlling means for operating a driving means in response to the driving signal.~~

~~———— Moreover, an infrared steering program according to the present invention for controlling a plurality of infrared controlled devices with a plurality of infrared controlling devices is characterized in that a matching signal is identified as a signal for the infrared controlled device in comparing the time interval between the termination time of the start signal and the initiation time of the steering signal transmitted by the infrared controlling device with the specific time interval previously fixed in every infrared controlled device.~~

### **Brief Description of Drawings**

FIG.1 is a pictorial view showing an embodiment of an infrared steering system according to the present invention;

FIG.2 is a block diagram of a ~~steering device showing the embodiment~~ controller of the infrared steering system according to the present invention;

FIG.3 is a flowchart of the steering controlling process ~~showing the embodiment~~ of the infrared steering system according to the present invention;

FIG.4 is a wave form chart showing ~~[[a]] transmission mode~~ modes of ~~[[a]] transmission signal~~ signals of the ~~embodiment~~ of the infrared steering system according to the present invention;

FIG.5 is a wave form chart of the transmission signal ~~showing the embodiment~~ of an infrared steering method according to the present invention;

FIG.6 is a block diagram of a first embodiment of the steered object ~~showing the embodiment of the infrared steering system~~ according to the present invention;

FIG.7 is a block diagram of ~~[[the]]~~ a second embodiment of the steered object ~~showing the second embodiment of the infrared steering system~~ according to the present invention;

FIG.8 is a flowchart of the steering controlling process ~~showing of~~ the second embodiment of the infrared steering method according to the present invention.

### **Best Mode For Carrying Out The Invention**

Other details, advantages, and characteristics will be apparent from the following embodiments with reference to the accompanying drawings.

~~The embodiment according to the present invention will be described in detail with reference to the drawings.~~ FIG.1 shows a constitution of an infrared steering system of an embodiment of the present invention. A plurality of infrared controllers 2, 4, 6, 8, 10 are respectively provided ~~with an infrared photo acceptance unit for determination of whether or not the~~

~~synchronization signal is outputted in response to presence or absence of other infrared transmission signals~~ to transmit an infrared carrier wave signal together with ~~[[a]]~~ steering information. As described later, the five infrared controllers 2, 4, 6, 8, 10, are respectively provided in their internal memory device with ~~ID of an~~ identification information for identifying a steered object and are classified into ~~five~~ types ~~[[of]]~~ 1 to 5. Furthermore, the infrared controllers 2, 4, 6, 8, 10 ~~transmits~~ transmit infrared signals that are synchronized ~~between reciprocal transmitting means respectively~~ among themselves.

~~Meanwhile, the~~ The five infrared controlled cars (hereinafter referred to as IR car) 12, 14, 16, 18, 20 ~~[[of]]~~ (the steered objects of the infrared controllers 2, 4, 6, 8, 10) are each provided with a driving means comprising an infrared controlled device, a motor, wheels, ~~and other mechanism (not shown)~~ and with an ID for identifying itself. ~~Further,~~ IR cars 12, 14, 16, 18, 20 receive the synchronized infrared signals e1, e2, e3, e4, e5 from the infrared controllers 2, 4, 6, 8, 10 ~~[[to]]~~ and decode the steering information included in the infrared ~~[[ray]]~~ signals.

~~Next, arrangements of the infrared controllers 2, 4, 6, 8, 10 and the IR cars 12, 14, 16, 18, 20 shall be described in FIG. 1. FIG. 2 is a block diagram of the infrared controllers 2, 4, 6, 8, 10 showing an embodiment of the infrared steering system according to the invention, where the infrared controller 2 and the IR car 12 are described as examples.~~

In the infrared controller 2, an operation switch 22 and an ID switch 24 are electrically connected with a CPU 26 which is in turn electrically

connected with an infrared LED 28 and an infrared receiving means 30.

The operation switch 22 is a means of inputting the steering information for steering the IR car 12. The operation switch 22 is provided with control switches including a steering operation switch for controlling travelling direction (not shown) and a driving switch for controlling travelling operation.

The ID switch 24 is constituted of a three bits digital switch, which is a switch for inputting ~~a setting~~ information for specifying eight types of the IR ~~[[car]] cars 12 identified~~ by means of three bits 000, 001, 010, ..., 111, and thus is an object setting means for providing ~~[[an]]~~ object identification information for specifying the steered object. The ID switch 24 is ~~constituted as a variable switch capable of setting being set~~ by a user. ~~Furthermore, the~~ The ID switch is not limited to three bits[[.]]; with more ~~Larger the number of bits, more steerable cars available can be steered.~~

The CPU 26 is constituted of a one chip microcomputer, including a ROM (program memory) and a RAM (work memory) though both are not shown and has a function of storing data into the RAM which is inputted from ports ~~corresponding to the data of~~ connected to the operation switch 22 and the ID switch 24. The CPU 26 runs a program stored in the ROM and controls the infrared controller 2 in accordance with the program.

The CPU 26 also selects a single transmission mode among five transmission modes corresponding to five of the eight types of ID set by the ID switch 24 and determines a waiting time from a synchronization signal with reference to the object identification information set by the ID switch 24



in accordance with the selected transmission mode to convert the steering information inputted from the operation switch 22 into a modulated signal.

The infrared LED 28 is an LED which receives the modulated signal from the CPU 26 and modulates an infrared carrier wave to emit the infrared signals e1, e2, e3, e4, e5.

The infrared receiving means 30 is a receiving means having a function of monitoring whether the synchronization signal is outputted from the other ~~transmitting means~~ controllers. When the synchronization signal transmitted ~~by the other transmitting means~~ from another controller is received, the controller is ~~[[to]]~~ synchronize ~~synchronized~~ with the synchronization signal and ~~output~~ outputs a control signal. When the synchronization signal is not received, the synchronization signal is ~~functionally outputted~~ output.

~~Subsequently, movement~~ Operation of the infrared controller 2 shall be described with reference to a flowchart (FIG.3) run by the CPU 26. In FIG.3, the CPU 26 first ~~performs initialization~~ initializes (step S101) ~~[[of]]~~ the memory (RAM) ~~and runs following loop process~~. Then, the CPU obtains ~~[[a]]~~ port data from a port corresponding to the ID switch 24 (step S102). Next, the CPU 26 calculates and determines (step S103) the first and second waiting times (1), (2) from ID data in a predetermined manner. The two waiting times (1), (2) ~~are a process of selecting~~ correspond to a transmission mode ~~in response to~~ for the ID obtained from the ID switch 24 among the five transmission modes for transmitting the steering information after elapse of five different waiting times from the start signal.

FIG.4 shows five transmission modes for transmitting information intermittently within the five different waiting times. Figure 5 shows the waiting times (1),(2). In the drawing, ~~first,~~ TYPE 1 detects no synchronization signal but outputs the synchronization signal and a start signal, then outputs the steering information signal after the second waiting time (2) A, and repeats the process and outputs ~~[[the]]~~ another synchronization signal after an interval of the first waiting time (1). ~~TYPE 1 repeats the processes.~~ Each of TYPE 2 to TYPE 5 receives the synchronization signal, synchronizes and outputs the start signal to output each steering information signal after the each respective second waiting time (2) B-E.

FIG.5 shows a timing chart of a data unit of period A in a TYPE 1 car, where ~~synchronization~~ s\_sync is a period for synchronizing with the other ~~transmitting means~~ controllers. Next, ~~period of~~ START is ~~[[a]]~~ start data indicating the beginning of ~~[[a]]~~ data. Each TYPE is distinguished depending on difference in the next period of WAIT (2). Then, the steering information is inputted and the time length of CH1, CH2, CH3 varies depending on electric potential of a control volume. The data unit is repeated after a period of WAIT (1).

In FIG.3, the CPU obtains the steering information and ~~each types of~~ information from the operation switch 22 (step S104, S108, S109) and determines the steering information.

The infrared controller 2 has a charging function and performs measurement (step S105) of the reference voltage and measurement (step

S105) of the battery terminal voltage. And then, the CPU determines (step S107) presence/absence of a battery and the charging is initiated (step S116) when the battery is connected. After that, the CPU determines whether or not two-minute charge time is terminated (step S117) and whether the battery is removed from the infrared controller 2 (step S118). The CPU performs the charge termination process (step S119) and finally reconfirms the presence or absence of the battery (step S120) and returns to the condition of obtaining the ID data (step S102).

When the battery for charge is not connected to the infrared controller 2, the transmission mode takes place, and then the CPU obtains the information of presence/absence of synchronization signal from the infrared receiving means 30 (step S110). When the synchronization signal is not detected during the waiting time (1) determined at ID setting (step S111), the synchronization signal is outputted automatically (step S112) in the order of start signal, waiting time (2) and steering signal (step S113, S114, S115).

A mechanism of an IR car 12 has two models. Model A controls travelling directions and travelling forward and backward by driving right wheels (WHEEL) and left wheels independently and model B controls the travelling directions and the travelling forward and backward by steering drive and travelling drive forward and backward. Either models are provided with two motors. Model A is constituted of a RIGHT motor for the right wheel drive and a LEFT motor for left wheel drive. Model B is constituted of a STEERING motor for a steering mechanism drive and a WHEEL motor for wheel drive.

FIG.6 is a block diagram showing an arrangement of a reception unit of the infrared steering system of the IR car 12 of model A.

In the reception unit of the infrared steering system of the IR car 12, the infrared receiving means 32 and CPU 34 are electrically connected. Moreover, the CPU 34 and an ID switch 36 are electrically connected. Furthermore, the CPU 34 is electrically connected to an R motor driver 38 which is an right motor drive unit. The R motor driver 38 is electrically connected to an R motor 40 which is mechanically connected to an R wheel 42. In left motor, similarly, the CPU 34 is electrically connected to an L motor driver 44 which is left motor driver unit. The L motor driver 44 is electrically connected to an L motor 46 which is mechanically connected to an L wheel 48.

The infrared receiving means 32 receives an infrared signal transmitted from the infrared controller 2 to convert the infrared signal into an electric signal.

The CPU 34 is constituted of one chip microcomputer including a ROM (program memory) and a RAM (work memory) which are not shown. The CPU 34 extracts the steering information obtained from the infrared receiving means 32 from a self-identification information and decodes the steering information produced by the infrared controller 2 to store in the RAM. Then, the program stored in the ROM is retrieved so that IR car 12 is controlled.

The ID switch 36 is constituted of a 3 ~~bits~~ bit digital switch. The 3 ~~bits~~ bit digital switch is a switch capable of setting eight ~~types~~ of numerical

values consisting of 000, 001, 010,...111. Each value corresponds to the eight types identified, the IR car 12 identifies itself from the setting and the switch 36 constitutes a self setting means for providing the self-identification information. The ID switch 36 is previously set during the manufacturing step and may be conveniently identified with a sticker and the like.

The CPU 34 after receiving the start signal extracts the steering signal ~~later~~ following ~~than~~ the waiting time (2) in accordance with the self-identification information set by the ID switch 36 to convert the steering information into a driving signal. Thus, the CPU 34 extracts the steering information after the waiting time (2) set by ~~theself-setting~~ the self-setting ID switch 36 from the start signal received in the infrared receiving means 32 and constitutes a signal converting means for converting into the driving signal.

The R (RIGHT) motor driver 38 converts an R motor data from the CPU 34 into the driving signal and supplies to the R motor 40 to drive the right wheel mechanism 42 (RWHEEL).

Also, the L motor driver 44 (LEFT) converts an L motor data from the CPU 34 into the driving signal and supplies to the L motor 46 to drive the left wheel mechanism 48.

FIG.7 is a block diagram showing constitution of a system of the IR car 12 of the model B. In ~~thedrawing~~ the drawing, units having the same constitution as the IR car 12 of the model A in FIG.6 are shown by the same reference and description overlapping with the description in FIG.6 is omitted. In FIG.7, a steering motor driver 50 converts an S (STEERING) motor data

from the CPU 34 into the driving signal and supplies to an S motor 52 to drive a steering (STEERING) mechanism 54.

Also, a W (WHEEL) motor driver 56 converts a W motor data from the CPU 34 into the driving signal and supplies to a W motor 58 to drive both wheel (WHEEL) mechanisms 60. Next, operations of the IR car 12 of the model A and the model B shall be described with reference to a flowchart which is run by the CPU 26. In FIG.8, the CPU initially performs initialization of a port and the like (step S201), and runs the following loop process. The CPU 26 obtains the ID data from an input port to determine the waiting time (1), (2) (step S202, S203). Then, the CPU 26 performs initialization of memory (RAM) (step S205) and checks the start data of the received infrared signal (step S204). Or the CPU 26 detects the start data which indicates the beginning of the data in a timing chart shown in FIG.5. When the CPU 26 detects no start pulse (absence), the CPU 26 continues check of the start data of step S205. When detecting the start pulse (presence), the CPU 26 performs measurement of CH1 data (step S206, S207) after the waiting time (2) determined by the ID data after the start pulse.

After obtaining the CH1 data, the CPU 26 discriminates the model (step S208) so that whether its own model is the model A or the model B may be discriminated. The discrimination is performed by a model SW. In case of the model A, output setting of the R motor 40 is performed (step S209), and the output setting of the L motor 46 is performed (step S210). Meanwhile, in case of the model B, the only output setting of the L motor 46 is performed (step S210).

Next, similarly to the CH1, the CPU 26 performs the discrimination of the model after obtaining the CH2 data and the CH3 data (step S211, S212). In case of own model A, the output setting of L motor and R motor takes place (step S214, S215). While, in case of the model B, only setting of the R motor 40 takes place (step S215).

The data is stored in memory (RAM) after each output setting (step S216).

After the output setting, the CPU 26 returns to the step S204 to check the start pulse. An output control is performed by the timer interruption. The CPU 26 discriminates whether or not values of timer resistors TF, TH of the RAM have reached values of T1, T2 set previously. The values of the timer resistors TF, TH are increased at every timer interruption (step S217). When the value of the TF reaches T1, the CPU 26 clears the output data (step S220) or retrieves the data (step S221) in response to presence or absence of a reception data (step S218, S219).

Next, when the value of the TH reaches the value of the T2 (step S222), the CPU 26 once updates the output (half reset, step S223). Finally, the output data is outputted to a corresponding motor driver (step S224). After that, the timer interruption is terminated to return to the main routine.

Thus, in the embodiment, the infrared controller 2 is constituted of a inputting means for receiving the steering information ~~in response to operation~~, an infrared receiving means for detecting ~~out put of~~ an infrared radio signal from ~~the other transmitting means~~ another controller, an object setting means for providing [[an]] object identification information for

specifying a steering object, a mode selecting means for selecting one of the transmission modes in response to the object identification information, a signal converting means for converting a synchronization signal, a start signal, and a steering information into a modulated signal, and a transmitting means for transmitting the infrared radio signal to which an infrared carrier wave signal is modulated by the modulated signal.

Also, the IR car 12 is constituted of a self setting means for providing a self-identification information, a means for receiving the infrared signal from the infrared controller 2, a means for extracting the steering information which is included in the infrared signal received by the receiving means, a signal converting means for converting the extracted steering information into the driving signal, and a drive controlling means for operating a driving means in response to the driving signal.

According to the embodiment, a plurality of steered objects are extracted in response to the time from the start signal free of the identification signal by synchronizing ~~between the transmitting means~~ among the controllers and different infrared radio signals are made depending on difference in time from the start signal. Thus, the identification information becomes unnecessary for each radio signal. Transmission time ~~during which each transmitting means occupies~~ may be abbreviated, so that more objects may be steered.

Furthermore, in the embodiment, the switch 36 for setting the ID at the side of the IR car 12 is provided previously set at the manufacturing operation, notwithstanding the switch 36 may be arranged by user's free



operation. Namely, in the IR car 12, the object identification information and the self-identification information are set in response to operation. Thus, users may set ID at the best conditions. For example, when common ID systems exist, ID setting may be changed in order to perform the steering simultaneously.

In the embodiment, the infrared ray is used as a radio signal carrying the steering information. VHF band and other electromagnetic wave may be used for the carrier wave.